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Applicant: Masanobu OHSAKI *et al.*

Title: MISFIRE DETECTING APPARATUS FOR INTERNAL COMBUSTION ENGINE AND METHOD THEREOF

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Examiner: Freddie KIRKLAND, III

Art Unit: 2855

PERFECTION OF CLAIM FOR CONVENTION PRIORITY

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

The benefit of the filing date of the following prior foreign application filed in the following foreign country was requested in a claim for convention priority that was filed on April 23, 2004, where the right of priority provided in 35 U.S.C. § 119 was claimed. Further to that claim of priority, in order to perfect that claim, filed herewith is a verified translation of the original foreign application:

- Japan Patent Application No. 2003-120324 filed April 24, 2003.

Date May 16, 2006

Respectfully submitted,

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THE COMMISSIONER IS HEREBY AUTHORIZED TO CHARGE ANY ADDITIONAL FEES WHICH MAY BE REQUIRED REGARDING THIS APPLICATION UNDER 37 C.F.R. §§ 1.16-1.17, OR CREDIT ANY OVERPAYMENT, TO DEPOSIT ACCOUNT NO. 19-0741. SHOULD NO PROPER PAYMENT BE ENCLOSED HEREWITH, AS BY A CHECK BEING IN THE WRONG AMOUNT, UNSIGNED, POST-DATED, OTHERWISE IMPROPER OR INFORMAL OR EVEN ENTIRELY MISSING, THE COMMISSIONER IS AUTHORIZED TO CHARGE THE UNPAID AMOUNT TO DEPOSIT ACCOUNT NO. 19-0741. IF ANY EXTENSIONS OF TIME ARE NEEDED FOR TIMELY ACCEPTANCE OF PAPERS SUBMITTED HEREWITH, APPLICANT HEREBY PETITIONS FOR SUCH EXTENSION UNDER 37 C.F.R. § 1.136 AND AUTHORIZES PAYMENT OF ANY SUCH EXTENSIONS FEES TO DEPOSIT ACCOUNT NO. 19-0741.

VERIFICATION OF TRANSLATION

I, Fujio SASAJIMA of c/o SASAJIMA & ASSOCIATES, Toranomon 1-chome Mori Bldg., 19-5, Toranomon 1-chome, Minato-ku, Tokyo 105-0001, Japan, am the translator of the documents attached and I state that the following is a true translation to the best of my knowledge and belief the foregoing is a true and correct translation made by me of Japanese Patent Application No. 2003-120324.

Date: May 15, 2006

BY

Fujio SASAJIMA

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[Attached Documents]
[Document] Specification 1
[Document] Drawings 1
[Document] Abstract 1

[Name of Document] SPECIFICATION

[Title of the Invention] MISFIRE DETECTING APPARATUS FOR INTERNAL COMBUSTION ENGINE

[Scope of Claims for Patent]

[Claim 1]

A misfire detecting apparatus for an internal combustion engine that judges whether or not a misfire occurred, based on the comparison between a rotational variation value of an engine and a misfire judgment value according to engine operating conditions, comprising the steps of:

judging whether or not said rotational variation value becomes larger averagely based on an average correlation between said rotational variation value and said misfire judgment value, and

canceling the misfire judgment when said rotational variation value is larger averagely.

[Claim 2]

A misfire detecting apparatus for an internal combustion engine comprising:

rotational-variation-value-detecting-means that detect a rotational variation value of the engine;

misfire-judgment-value-setting-means that set a misfire judgment value compared with said rotational variation value, according to engine operating conditions;

misfire-judging-means that judge whether or not a misfire occured based on a comparison between said rotational variation value and said misfire judgment value; and

misfire-judgment-canceling-means that cancel the misfire judgment of said misfire-judging-means based on an average correlation between said rotational variation value and said misfire judgment value.

[Claim 3]

The misfire detecting apparatus for the internal combustion engine according to claim 2, wherein

said misfire-judgment-canceling-means cancel the misfire judgment of said misfire-judging-means, by comparing a ratio between an average value of said rotational variation value and an average value of said misfire judgment value with a predetermined misfire judgment value.

[Claim 4]

The misfire detecting apparatus for the internal combustion engine according to claim 2, wherein

said misfire-judgment-canceling-means cancel the misfire judgment of said misfire-judging-means, by comparing an average value of ratios between said rotational variation value and said misfire judgment value with a predetermined cancellation judgment value.

[Claim 5]

The misfire detecting apparatus for the internal combustion engine according to claim 3 or claim 4, wherein

said predetermined cancellation judgment value is calculated according to an engine load and an engine rotation speed.

[Claim 6]

The misfire detecting apparatus for the internal combustion engine according to one of claims 2 through 5, wherein

said misfire-judgment-canceling-means eliminate said rotational variation value and said misfire judgment value of when said rotational variation value is equal to or above said misfire judgment value, from said average correlation.

[Claim 7]

The misfire detecting apparatus for the internal combustion engine according to claim 6, which is provided with

cancellation-prohibiting-means according to said number of samples that prohibit the cancellation of the misfire judgment of said misfire-judgment-canceling-means, when the number of samples of said rotational variation value and said misfire judgment value, which

said average correlation is based on, is less than a predetermined value.

[Claim 8]

The misfire detecting apparatus for the internal combustion engine according to one of claims 2 through 7, which is provided with

cancellation-prohibiting-means according to a misfire frequency that prohibit the cancellation of the misfire judgment of said misfire-judgment-canceling-means, when the misfire frequency during a period of time where said average correlation is obtained, is equal to or above a predetermined value.

[Claim 9]

The misfire detecting apparatus for the internal combustion engine according one of claims 2 through 8, wherein

said misfire-judgment-canceling-means obtain said average correlation, as an average value per a predetermined number of ignitions.

[Claim 10]

The misfire detecting apparatus for the internal combustion engine according to claim 9, wherein:

said misfire-judging-means output a misfire judgment signal, when the misfire frequency per the predetermined number of ignitions is accumulated by the predetermined number of times, and when said accumulated value is equal to or above a predetermined value; and

said misfire-judgment-canceling-means prohibit output of the misfire judgment signal based on said accumulated value.

[Detailed Description of the Invention]
[0001]
[Technical Field of the Invention]

The present invention relates to a misfire detecting apparatus for an internal combustion engine for judging whether or not a misfire occurred, based on a rotational variation of an engine.

[0002]

[Prior Art]

In the conventional technique, as a misfire detecting apparatus for an internal combustion engine, there is an apparatus in which a rotational variation value of an engine (diagnosis data) is detected, and the rotational variation value and a misfire judgment value (threshold) according to engine operating conditions are compared with each other, to judge whether or not a misfire occurred (for example, refer to patent documents 1 and 2).

[0003]

[the Patent Document 1]

Japanese Unexamined Patent Publication No. 04-171249

[the Patent Document 2]

Japanese Unexamined Patent Publication No. 58-051243

[0004]

[Problems to be solved by the Invention]

In an internal combustion engine, the engine rotation speed is varied due to a misfire, and is also varied due to the loosening of a flywheel or the manual transmission of a clutch as deteriorating with age.

[0005]

Further, during the rough road running of a vehicle, there is a case where the engine rotation speed is varied due to a change in power caused by a slight variation of an accelerator opening, or a change in traction of a driving wheel, according to the vehicle body vibration.

[0006]

In the conventional technique, although the misfire judgment value is set according to the engine load and the engine rotation speed to respond differences of the engine-rotation-speed variation based on differences of the engine operating conditions, there is a

problem in that it is erroneously judged that a misfire occurred, when the engine rotation speed is varied due to the factor as described above other than the misfire.

[0007]

The present invention has an object to provide a misfire detecting apparatus that detects a misfire based on a variation of an engine rotation speed, which does not erroneously judge that the misfire occurred, when the engine rotation speed is varied due to a factor other than the misfire, e.g., a loosening of a flywheel or a clutch, and the rough road running.

[0008]

[Means for solving the Problems]

Therefore, In the inventions according to claims 1 and 2, it is constituted that the misfire judgment is canceled based on an average correlation between the rotational variation value and the misfire judgment value.

[0009]

According to such a configuration, as the rotational variation value becomes larger averagely due to the loosening of the flywheel or the clutch, and the rough road running, the apparatus judges whether or not the rotational variation value becomes larger averagely, based on the average correlation between the rotational variation value and the misfire judgment value.

[0010]

When the rotational variation value becomes larger averagely, it is estimated that the rotational variation value is influenced by the loosening of the flywheel or the clutch, and the rough road running, and the misfire judgment is canceled based on the comparison between the rotational variation value and the misfire judgment value.

[0011]

Therefore, it is possible to avoid the misjudgment of the misfire based on enlarged rotational variation value influenced by the loosening or the rough road running.

In the invention according to claim 3, it is constituted that the misfire judgment is canceled by comparing the ratio between the average value of said rotational variation value and the average value of the misfire judgment value with the predetermined misfire judgment value.

[0012]

According to such a configuration, it is determined whether or not the rotational variation value becomes larger averagely, by comparing the ratios between the average values of the rotational variation value and the average value of the misfire judgment value, which average values are obtained at the same time.

[0013]

Therefore, it is possible to determine with a high accuracy whether or not the rotational variation value tends to become larger than that in the normal time, by obtaining the average correlation between the rotational variation value and the misfire judgment value as a rate of the rotational variation value to the misfire judgment vale.

[0014]

Note that the average values of the rotational variation value and the misfire judgment value include an accumulated value in addition to the average value.

In the invention according to claim 4, it is constituted that the misfire judgment is canceled, by comparing the average value of ratios between the rotational variation value and the misfire judgment value with the predetermined cancellation judgment value.

[0015]

According to such a configuration, it is determined whether or not the rotational variation value tends to become larger than that in the normal time, by obtaining the ratio between the rotational variation

value and the misfire judgment value, as well as the average value of the ratio, and by comparing the average value of the ratio and the cancellation judgment value.

[0016]

Consequently, it is possible to determine with a high accuracy whether or not the rotational variation value tends to become larger than that in the normal time, by obtaining the average correlation between the rotational variation value and the misfire judgment value as a rate of the rotational variation value to the misfire judgment value.

[0017]

In the invention according to claim 5, it is constituted that the predetermined cancellation judgment value is calculated according to the engine load and the engine rotation speed.

According to such a configuration, comparing the average value of the ratio between the rotational variation value and the misfire judgment value with the cancellation judging value calculated according to the engine load and the engine rotation speed, the misfire judgment is canceled based on the result of the comparison.

[0018]

Consequently, it is possible to improve the judgment accuracy by calculating the cancellation judgment value optimum for the engine operating conditions.

In the invention according to claim 6, it is constituted that the rotational variation value and the misfire judgment value of when the rotational variation value is equal to or above the misfire judgment value, is eliminated from the average correlation.

[0019]

According to such a configuration, the rotational variation value and the misfire judgment value of when the occurrence of the misfire is judged according to the rotational variation value being equal to or above the misfire judgment value, are not used for samples to obtain the average correlation. The average correlation is obtained based

on the rotational variation value and the misfire judgment value of when the occurrence of the misfire is judged according to the comparison between the rotational variation value and the misfire judgment value.

[0020]

Consequently, it is possible to avoid the cancellation of the misfire judgment in mistake, when a large rotational variation caused by the misfire influences detection results of the average correlation between the rotational variation value and the misfire judgment value.

[0021]

In the invention according to claim 7, it is constituted that, the misfire judgment is canceled, when the number of samples of each of the rotational variation value and the misfire judgment value, which the average correlation is based on, is less than the predetermined value.

[0022]

According to such a configuration, if the number of samples of each of the rotational variation value and the misfire judgment value of when the average correlation of the rotational variation value and the misfire judgment value is obtained, is small, the misfire judgment based on the average correlation is canceled because it is difficult to judge the influence caused by such as loosening or the rough road running with high accuracy.

[0023]

Consequently, it is possible to avoid the unnecessary cancellation of the misfire judgment by erroneously judging the influence caused by such as the loosening or the rough road running when the number of samples is small.

In the invention according to claim 8, it is constituted that, the misfire judgment is canceled when the misfire frequency during a period of time where the average correlation is obtained, is equal to or above the predetermined value.

[0024]

According to such a configuration, when the misfire frequency during a period of time where the average correlation is obtained, is equal to or above the predetermined value, even if there is the influence caused by the loosening or the rough road running, the possibility of the actual misfire is high, the cancellation of the misfire judgment is prohibited.

[0025]

Consequently, it is possible to avoid the cancellation of the misfire judgment according to the average correlation between the rotational variation value and the misfire judgment value, when the possibility of the actual misfire is high.

In the invention according to claim 9, it is constituted that, the average correlation between the rotational variation value and the misfire judgment value is obtained as an average value per the predetermined number of ignitions.

[0026]

According to such a configuration, the average correlation between the rotational variation value and the misfire judgment value is obtained by obtaining the average value of the rotational variation value and the misfire judgment value per the predetermined number of ignitions, or by obtaining the average value of the ratio between the rotational variation value and the misfire judgment value.

[0027]

Consequently, it is possible to simply and adequately obtain the average correlation between the rotational variation value and the misfire judgment value.

In the invention according to claim 10, it is constituted that, the misfire judgment signal is outputted when the misfire frequency per the predetermined number of ignitions is accumulated by the predetermined number of times, and when the accumulated value is equal to or above the predetermined value, and the output of the

misfire judgment signal is prohibited based on the average correlation between the rotational variation value and the misfire judgment value.

[0028]

According to such a configuration, when the misfire frequency per the predetermined number of ignitions is obtained, and the misfire frequency is accumulated by the predetermined number of times, and if the accumulated value is equal to or above the predetermined value, it is judged the actual misfire is continuously occurred, which is not the influence of the noise. Thus, the misfire judgment signal is outputted. However, when it is estimated there is the influence caused by the loosening or the rough road running, based on the average correlation between the rotational variation value and the misfire judgment value, even if the accumulated value of the misfire frequency is equal to or above the predetermined value, the output of the misfire judgment value is canceled.

[0029]

Consequently, it is possible to avoid the erroneous judgment of the misfire due to the influence of noise, and to avoid the erroneous judgment of the misfire due to the influence by the loosening or the rough road running.

[0030]

[Embodiment of the Invention]

Embodiments of the invention will be explained with reference to the accompanying drawings.

FIG. 1 is diagram showing a system configuration of an internal combustion engine in an embodiment.

[0031]

In FIG. 1, an electronically controlled throttle chamber 104 is disposed in an intake pipe 102 of an internal combustion engine 101.

Electronically controlled throttle chamber 104 consists of a throttle valve 103b and a throttle motor 103a driving throttle valve 103b to open/close.

Air is sucked into a combustion chamber 106 of engine 101 via electronically controlled throttle chamber 104 and an intake valve 105.

[0032]

A combusted exhaust gas is discharged from combustion chamber 106 via an exhaust valve 107, and is purified by a front catalytic converter 108 and a rear catalytic converter 109, and then emitted into the atmosphere.

Intake valve 105 and exhaust valve 107 are driven to open/close by cams disposed to an intake side camshaft 110A and to an exhaust side camshaft 110B, respectively.

[0033]

An electromagnetic fuel injection valve 112 is disposed in an intake port 111 on the upstream side of intake valve 105.

Fuel injection valve 112 is driven to open by an injection pulse signal output from an engine control unit (to be abbreviated as ECU hereunder) 113, to inject fuel adjusted at a predetermined pressure toward intake valve 105.

[0034]

Note, the engine may be such a type, direct injection by in-cylinder, that fuel injection valve 112 directly injects fuel into combustion chamber.

An air-fuel mixture formed in each cylinder is ignited to burn with the spark ignition by an ignition plug 114.

[0035]

Ignition plug 114 is provided with an ignition coil 114A incorporating therein a power transistor.

ECU 113 performs a switching control of the power transistor, to independently control ignition timing (an ignition timing advance value) of each cylinder.

[0036]

ECU 113 receives detection signals from an accelerator pedal sensor APS 116 detecting an accelerator opening, an air flow meter 115 detecting an intake air amount Q of engine 101, a crank angle sensor 117 taking out a position signal POS for each unit crank angle from a crankshaft 121, a throttle sensor 118 detecting an opening TVO of throttle valve 103b, a water temperature sensor 119 detecting a cooling water temperature Tw of engine 101, a cam sensor 120 taking out a cylinder judgment signal PHASE from intake side camshaft 110A, and the like.

ECU 113 calculates an engine rotation speed Ne based on the position signal POS.

[0037]

Further, ECU 113 has a function of judging an occurrence of misfire based on a variation of the engine rotation speed Ne, as software. Such a misfire judging function will be described in accordance with flowcharts of FIG. 2 and FIG. 3.

[0038]

The flowchart of FIG. 2 shows a routine executed every one ignition.

In step S1, an ignition counter for counting the number of ignition times is counted up.

In step S2, an engine load Tp and the engine rotation speed Ne are read.

[0039]

Note, the engine load Tp can be represented by a basic injection quantity in fuel injection valve 112, a cylinder intake air amount, a throttle opening or the like.

In step S3, it is judged whether or not the engine load Tp and the engine rotation speed Ne read in step S2 are within previously set ranges, respectively.

Then, if the engine load Tp and the engine rotation speed Ne are within the previously set ranges, control proceeds to step S4.

[0040]

In step S4, rotational variation value (diagnosis data) ΔNe indicating the variation of the engine rotation speed Ne is calculated based on the detection signal from crank angle sensor 117.

The rotational variation value ΔNe is calculated as a deviation between the engine rotation speeds Ne calculated at least two crank angle positions within one ignition cycle.

[0041]

Crank angle sensor 117 and a processing of step S4 corresponds to rotational-variation-value-detecting-means.

In step S5, referring to a map storing a misfire judgment value (threshold) SL for misfire judgment in each region, which is previously classified depending on the engine load Tp and the engine rotation speed Ne, the threshold SL corresponding to the engine load Tp and the engine rotation speed Ne at that time is calculated.

[0042]

Note, the threshold SL is previously set, so that the diagnosis data ΔNe exceeds the threshold SL when a misfire occurred.

A processing of step S5 corresponds to misfire-judgment-value-setting-means.

[0043]

In step S6, it is judged whether or not the rotational variation value ΔNe is equal to or above the misfire judgment value SL.

Then, if the rotational variation value ΔNe is equal to or above the misfire judgment value SL, control proceeds to step S7, where a misfire counter is counted up.

[0044]

Note, if the rotational variation value ΔNe is equal to or above the misfire judgment value SL, the possibility of the misfire occurrence is high. However, in the embodiment, as described below, a frequency of judging that the rotational variation value ΔNe is equal to or above the misfire judgment value SL (a misfire frequency), is

obtained every 400 ignitions, and the misfire frequency is accumulated every 2000 ignitions. When it is judged that the accumulated misfire frequency is equal to or above a predetermined value, a final misfire judgment signal is outputted. This processing corresponds to misfire-judging-means.

[0045]

On the other hand, if the rotational variation value ΔNe is less than the misfire judgment value SL, control proceeds to step S8.

In step S8, an accumulated value $\Sigma\Delta Ne$ up to the previous time is added with the present rotational variation value ΔNe, to update the accumulated value $\Sigma\Delta Ne$.

[0046]

In the next step S9, an accumulated value ΣSL up to the previous time is added with the present misfire judgment value SL, to update the accumulated value ΣSL.

In step S10, an accumulation counter is counted up.

[0047]

In step S11, it is judged whether or not a value of the ignition counter reaches 400, and if the value of the ignition counter=400, control proceeds to step S12.

The ignition counter is reset to 0 when control proceeds to S12 and the subsequent steps as described later. Therefore, control proceeds to step S12 and the subsequent steps every 400 ignitions.

[0048]

In step S12, a ratio between the value of the misfire counter and 400 as the total number of ignition times is calculated as data indicating a misfire frequency.

In step S13, it is judged whether or not a value of the accumulation counter is equal to or above a predetermined value A.

[0049]

Then, if the value of the accumulation counter is less than the predetermined value A, and the number of samples of each of the accumulated value $\Sigma\Delta Ne$ and the accumulated value ΣSL is less than the predetermined value A, control proceeds to step S16.

[0050]

In step S16, the misfire frequency presently obtained in step S12 is added to a misfire frequency accumulated value up to the previous time, to update the misfire frequency accumulated value.

The misfire frequency accumulated value is used for judging as to whether a final misfire judgment signal (misfire warning) is output, in a routine shown in the flowchart of FIG. 3.

[0051]

When control proceeds from step S13 to step S16, as described below, cancel of the misfire judgment do not occur. Hence, a comparison processing of step S13 corresponds to cancellation-prohibiting-means according to the number of samples.

[0052]

On the other hand, in the case where the value of the accumulation counter is equal to or above the predetermined value A, that is, in the case where the number of samples of each of the accumulated value $\Sigma\Delta Ne$ and the accumulated value ΣSL is equal to or above the predetermined value A, control proceeds to step S14.

[0053]

In step S14, it is judged whether or not a ratio between the accumulated value $\Sigma\Delta Ne$ and the accumulated value ΣSL is equal to or above the previously set cancellation judgment value.

Here, if $\Sigma\Delta Ne/\ \Sigma SL$ is less than the cancellation judgment value, control proceeds to step S16, where the misfire frequency accumulated value is updated.

[0054]

On the other hand, if $\Sigma\Delta Ne/\Sigma SL$ is equal to or above the cancellation judgment value, control proceeds to step S15, where it is judged whether or not the misfire frequency obtained in step S12 is equal to or above a predetermined value.

[0055]

Then, if the misfire frequency is equal to or above the predetermined value, control proceeds to step S16, where the misfire frequency accumulated value is updated. If the misfire frequency is less than the predetermined value, control proceeds to step S17, where 1 is set to a cancellation flag.

[0056]

A comparison processing of step S15 corresponds to cancellation-prohibiting-means according to the misfire frequency.

$\Sigma\Delta Ne/\Sigma SL$, which is a value that becomes larger when the rotational variation value ΔNe becomes larger averagely to approach the misfire judgment value SL, is parameter indicating an average correlation between the rotational variation value ΔNe and the misfire judgment value SL.

[0057]

Note, a simple average of the rotational variation value ΔNe is obtained if $\Sigma\Delta Ne$/the number of accumulating times, and a simple average of the misfire judgment value SL is obtained if ΣSL/the number of accumulating times. However, since [$\Sigma\Delta Ne$/the number of accumulating times]/[ΣSL/the number of accumulating times]= $\Sigma\Delta Ne/\Sigma SL$, the division by the number of accumulating times is omitted.

[0058]

Namely, $\Sigma\Delta Ne/\Sigma SL$ corresponds to a ratio between the simple average of the rotational variation value ΔNe and the simple average of the misfire judgment value SL, and $\Sigma\Delta Ne$ is an average value of the rotational variation value ΔNe and ΣSL is an average value of the misfire judgment value SL.

[0059]

Further, in the calculation of $\Sigma\Delta Ne$ and ΣSL, since a value of when the occurrence of misfire is judged, is eliminated, the average correlation between the rotational variation value ΔNe and the misfire judgment value SL, which is indicated by $\Sigma\Delta Ne/\Sigma SL$, shows with accuracy an increase tendency of rotation variation due to a factor other than misfire.

[0060]

Here, in the case where $\Sigma\Delta Ne/\Sigma SL$ is equal to or above the cancellation judgment value, it is indicated that the rotational variation value ΔNe becomes larger averagely than that in the normal time.

Then, it is judged that an increase tendency of the rotational variation value ΔNe is caused by a factor other than misfire, such as the loosening of a flywheel, the deterioration of a clutch or the rough road running of a vehicle.

[0061]

Here, if the rotation variation of the engine becomes larger averagely, the rotational variation value ΔNe exceeds the misfire judgment value SL due to a slight increase of rotation variation, which is not caused by a misfire. Therefore, there is a possibility of erroneous judgment of misfire.

[0062]

Contrary to the above, in the case where $\Sigma\Delta Ne/\Sigma SL$ is less than the cancellation judgment value, it is estimated that there is no increase of rotation variation caused by a factor other than misfire, such as the loosening of the flywheel, the deterioration of the clutch or the rough road running of the vehicle.

Then, if there is no increase of rotation variation caused by a factor other than misfire, it is determined that the misfire judgment can be performed with accuracy based on the comparison between the rotational variation value ΔNe and the misfire judgment value SL.

[0063]

Therefore, in the case where $\Sigma\Delta Ne/\Sigma SL$ is less than the cancellation judgment value, control proceeds to step S16, where the misfire frequency presently obtained in step S12 is added to the misfire frequency accumulated value up to the previous time, to update the misfire frequency accumulated value.

[0064]

On the other hand, in the case where $\Sigma\Delta Ne/\Sigma SL$ is equal to or above the cancellation judgment value, there is a possibility of erroneous judgment of misfire. However, if the misfire frequency is equal to or above the predetermined value, it is estimated that a misfire actually occurred even if the rotation speed variation is increased caused by a factor other than misfire, such as the loosening of the flywheel, the deterioration of the clutch or the rough road running of the vehicle.

Accordingly, even if $\Sigma\Delta Ne/\Sigma SL$ is equal to or above the cancellation judgment value, in the case where the misfire frequency is equal to or the predetermined value, control proceeds to step S16, where the misfire frequency accumulated value is updated.

[0065]

Further, in the case where $\Sigma\Delta Ne/\Sigma SL$ is equal to or above the cancellation judgment value and also the misfire frequency is less than the predetermined value, it is judged that the presently obtained misfire frequency is resulted from an influence by the increase of rotation variation caused by a factor other than misfire, such as the loosening of the flywheel, the deterioration of the clutch or the rough road running of the vehicle.

Then, in such a case, 1 is set to the cancellation flag so that the presently obtained misfire frequency is not used for a final misfire judgment.

[0066]

If the accumulation counter has a value less than the predetermined value A, and if the number of samples of the rotational variation value ΔNe from which the accumulated value $\Sigma\Delta Ne$ and the

accumulated value ΣSL is evaluated is not enough, it is impossible to judge with high accuracy by an influence, such as the loosening of the flywheel, the deterioration of the clutch or the rough road running of the vehicle, on the rotational variation value ΔNe, based on $\Sigma\Delta Ne/\Sigma SL$.

[0067]

Therefore, the setting of the cancellation flag based on whether or not $\Sigma\Delta Ne/\Sigma SL$ is equal to or above the cancellation judgment value, is performed only when the accumulation counter has a value equal or above the predetermined value A.

Consequently, if the accumulation counter has the value less than the predetermined value A, control proceeds to step S16, where the misfire frequency accumulated value is updated, to avoid the cancellation of misfire judgment.

[0068]

In step S18, the ignition counter, the accumulation counter, the misfire counter, and the accumulated values $\Sigma\Delta Ne$ and ΣSL, are cleared, to terminate the present routine.

The flowchart of FIG. 3 shows a routine executed every 2000 ignitions.

In step S21, it is judged whether or not 1 is set to the cancellation flag.

[0069]

If 1 is set to the cancellation flag, control proceeds to step S22, where the misfire frequency accumulated value and the cancellation flag are cleared to terminate the present routine. As a result, the misfire warning based on the misfire frequency accumulated value (an output control of misfire judgment signal) is canceled.

[0070]

Accordingly, when the misfire frequency unrelated to actual misfire becomes larger according to the rotational variation value ΔNe being larger by the influence, such as the loosening of the flywheel, the deterioration of the clutch or the rough road running of the vehicle,

it is possible to prevent the erroneous misfire warning. Therefore, it is possible to increase the reliability of the misfire judgment.

[0071]

A processing of setting 1 to the cancellation flag in step S17 based on a comparison processing of step S14 and a processing proceed to step S22 based on the judgment of step S21 correspond to misfire-judgment-canceling-means.

[0072]

On the other hand, if it is judged in step S21 that 0 is set to the cancellation flag, control proceeds to step S23, where it is judged whether or not the misfire frequency accumulated value is equal to or above a predetermined value X.

[0073]

The misfire frequency is obtained every 400 ignitions while the present routine is executed every 2000 ignitions. Therefore, the misfire frequency accumulated value to be compared with the predetermined value X in step S23 becomes a value obtained by accumulating sequentially the misfire frequency obtained every 400 ignitions by the five numbers of times.

[0074]

If it is judged in step S23 that the misfire frequency accumulated value is equal to or above the predetermined value X, control proceeds to step S24, where the misfire warning is given to a driver by means of a warning device 123, such as a lamp, a buzzer or the like.

[0075]

Note, the configuration of the present embodiment has been such that the output of the final misfire judgment signal is an output of an operation signal of warning device 123. However, the present invention is not limited thereto, and the configuration may be such that, for example, the misfire judgment signal is made a prohibition signal

of the lean air-fuel ratio combustion, to forcibly shift a target air-fuel ratio from a lean air-fuel ratio to a stoichiometric air-fuel ratio.

[0076]

In step S25, the misfire frequency accumulated value is cleared, to terminate the present routine.

In the embodiment, it is possible that ΔNe/SL is calculated at each time when the rotational variation value ΔNe is calculated, and the accumulated value of ΔNe/SL is used as the data indicating the average correlation between the rotational variation value ΔNe and the misfire judgment value SL.

[0077]

An embodiment having the above configuration is shown in a flowchart of FIG. 4.

The flowchart of FIG. 4 differs from the flowchart of FIG. 2 only in steps S8A, S9A and S14A. Therefore, the steps in the flowchart of FIG. 4, which execute the same processing as in the steps in the flowchart of FIG. 2, are denoted by the same numerals as in the flowchart of FIG. 2, and the description thereof is omitted.

[0078]

In step S8A in the flowchart of FIG. 4, a ratio between the presently calculated rotational variation value ΔNe and the misfire judgment value SL (ratio=ΔNe/SL) is calculated.

In step S9A, the accumulated value Σ [ΔNe/SL] of ΔNe/SL is updated.

[0079]

Then, ΔNe/SL is accumulated between each 400 ignitions, and control proceeds to step S14A, where it is judged whether or not the accumulated value Σ[ΔNe/SL]/the number of accumulating times, i.e., average value of Σ[ΔNe/SL], is equal to or above the previously set cancellation judgment value.

[0080]

In the present embodiment, an average value of $\Delta Ne/SL$ is parameter indicating an average correlation between the rotational variation value ΔNe and the misfire judgment value SL.

In the case where the accumulated value $\Sigma[\Delta Ne/SL]$/the number of accumulating times is less than the cancellation judgment value, it is judged that there is no influence by the loosening of the flywheel or the clutch, or the rough road running of the vehicle, and control proceeds to step S16 in which the misfire frequency is accumulated.

[0081]

On the other hand, if the accumulated value $\Sigma[\Delta Ne/SL]$/t- he number of accumulating times is equal to or above the cancellation judgment value, it is further judged in step S15 whether or not the misfire frequency is equal to or above the predetermined value.

If the misfire frequency is less than the predetermined value, and it is not an apparent misfired condition, it is estimated that there is an influence by the loosening of the flywheel or the clutch, or the rough road running of the vehicle, and control proceeds to step S17, where 1 is set to the cancellation flag.

[0082]

Further, if the misfire frequency is equal to or above the predetermined value, it is judged that a misfire actually occurred even if there is an influence by the loosening of the flywheel or the clutch, or the rough road running of the vehicle, and therefore, control proceeds to step S16 in which the misfire frequency is accumulated.

[0083]

Also in the above embodiment, the rotation variation becomes larger due to an influence, such as the loosening of the flywheel or the clutch, or the rough road running of the vehicle. Thus, it is possible to avoid the erroneous judgment of misfire.

[0084]

Note, in the above embodiment, the configuration has been such that timing for obtaining the average correlation between the diagnosis data ΔNe and the threshold SL is every 400 ignitions, and the final misfire judgment is performed every 2000 ignitions. However, it is apparent that the present invention is not limited to such number of ignition times.

[0085]

Further, it is also possible to omit the judgment of accumulation counter in step S13 and/or the judgment of misfire frequency in step S15.

The configuration can be such that the cancellation judgment is set according to engine operation conditions. An embodiment having such a configuration is shown in a flowchart of FIG. 5.

[0086]

In the flowchart of FIG. 5, steps S10a and S10b for setting the cancellation judgment value are added to the flowchart of FIG. 4. Thus, the cancellation judgment value is different from that of step S14.

[0087]

In step S10a, the cancellation judgment value is calculated based on the engine load and the engine rotation speed.

The calculation of the cancellation judgment value can be performed by previously setting a map in which the cancellation judgment value is stored according to the engine load and the engine rotation speed, to retrieve the map.

[0088]

In the next step S10b, the cancellation judgment value is accumulated.

Then, in step S14B, an average value is obtained by dividing the accumulated value of the cancellation judgment value by the number of accumulating times, and this average value of the cancellation judgment value and the average value of ΔNe/SL are

compared with each other.

[0089]

According to the above configuration, the cancellation judgment value optimum for the engine operating conditions (engine load, engine rotation speed) can be calculated, to improve the judgment accuracy.

Note, as in the case of the flowchart of FIG. 2, it is apparent that, in the configuration where $\Sigma\Delta Ne/\Sigma SL$ and the cancellation judgment value are compared with each other, the cancellation judgment value can be calculated according to the engine operating conditions (engine load, engine rotation speed) as in the flowchart of FIG. 5.

[Brief Description of the Drawings]

[FIG. 1] a diagram shows a system configuration of an internal combustion engine in an embodiment.

[FIG. 2] a flowchart shows an update control of a misfire frequency accumulated value in the embodiment.

[FIG. 3] a flowchart shows a misfire judgment control in the embodiment.

[FIG. 4] a flowchart shows a second embodiment of the update control of the misfire frequency accumulated value.

[FIG. 5] a flowchart shows an embodiment for calculating a threshold for cancellation judgment according to engine operating conditions.

[Explanation of Reference Numerals]

101・・・internal combustion engine, 113・・・engine control unit (ECU), 117・・・crank angle sensor, 119・・・water temperature sensor, 120・・・cam sensor, 121・・・crankshaft, 123・・・warning device

[Name of Document] ABSTRACT

[Abstract]

[Subject] To avoid decrease of a misfire judgment accuracy due to the influence, such as the loosening of the flywheel, the deterioration of the clutch or the rough road running of the vehicle.

[Means for solving the Subject] As well as comparing a rotational variation value ΔNe of an engine and a misfire judgment value SL (S6), each of the rotational variation value ΔNe and the misfire judgment value SL of when it is judged that no misfire is occurred, is accumulated (S8-S10). Further, when the accumulation value of the each of the rotational variation value ΔNe and the misfire judgment value SL between every 400 ignitions is equal to or above a predetermined value (S13), when accumulated value $\Sigma\Delta Ne$ / accumulated value $\Sigma\Delta SL$ is equal to or above a predetermined value (S14), and when a misfire frequency between 400 ignitions is less than the predetermined value (S15), a final misfire judgment based on the accumulated value of the misfire frequency between 400 ignitions is canceled (S17).

[Selected Drawing] FIG. 2

[Name of Document] DRAWINGS

FIG.1

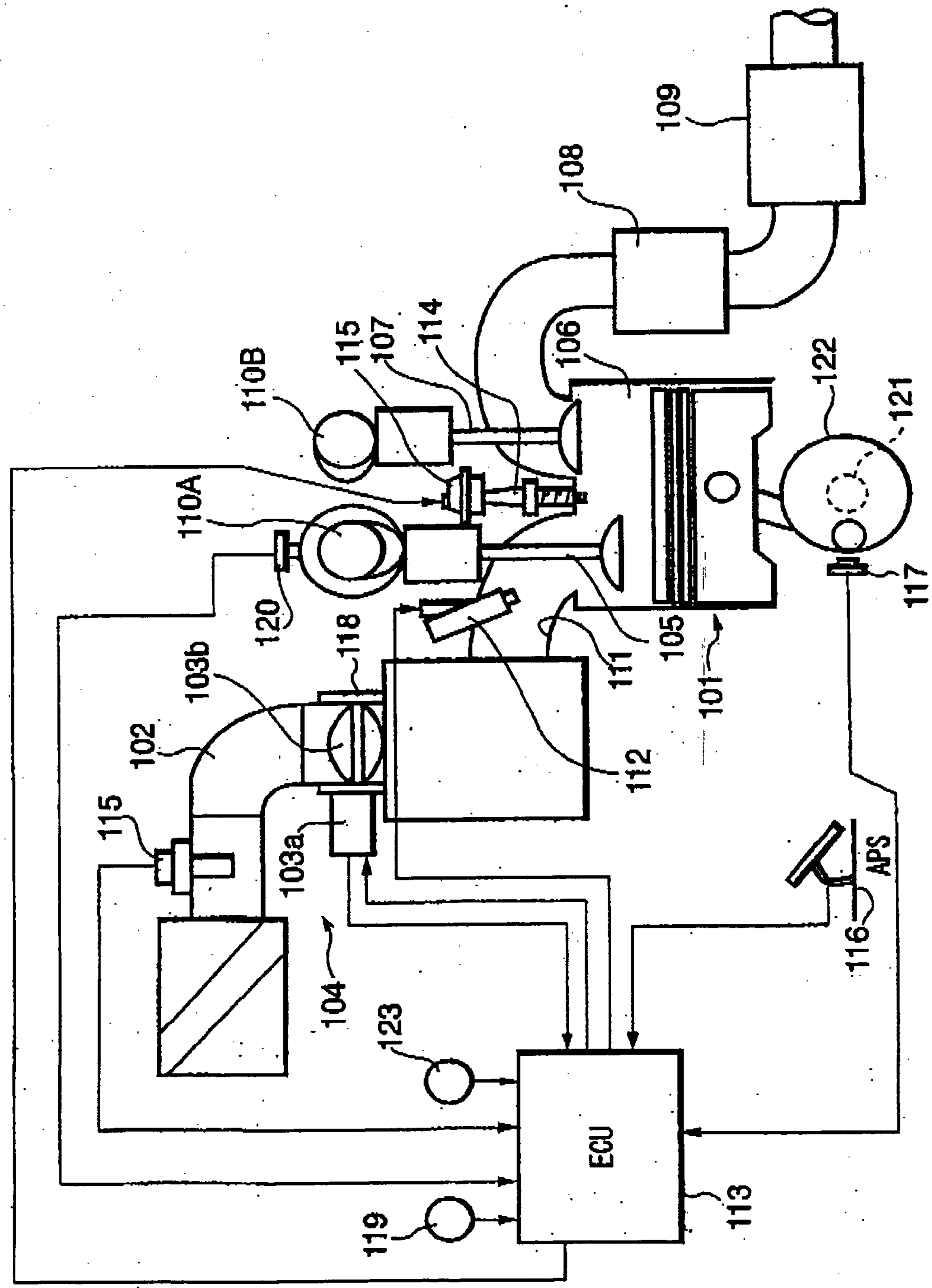


FIG.2

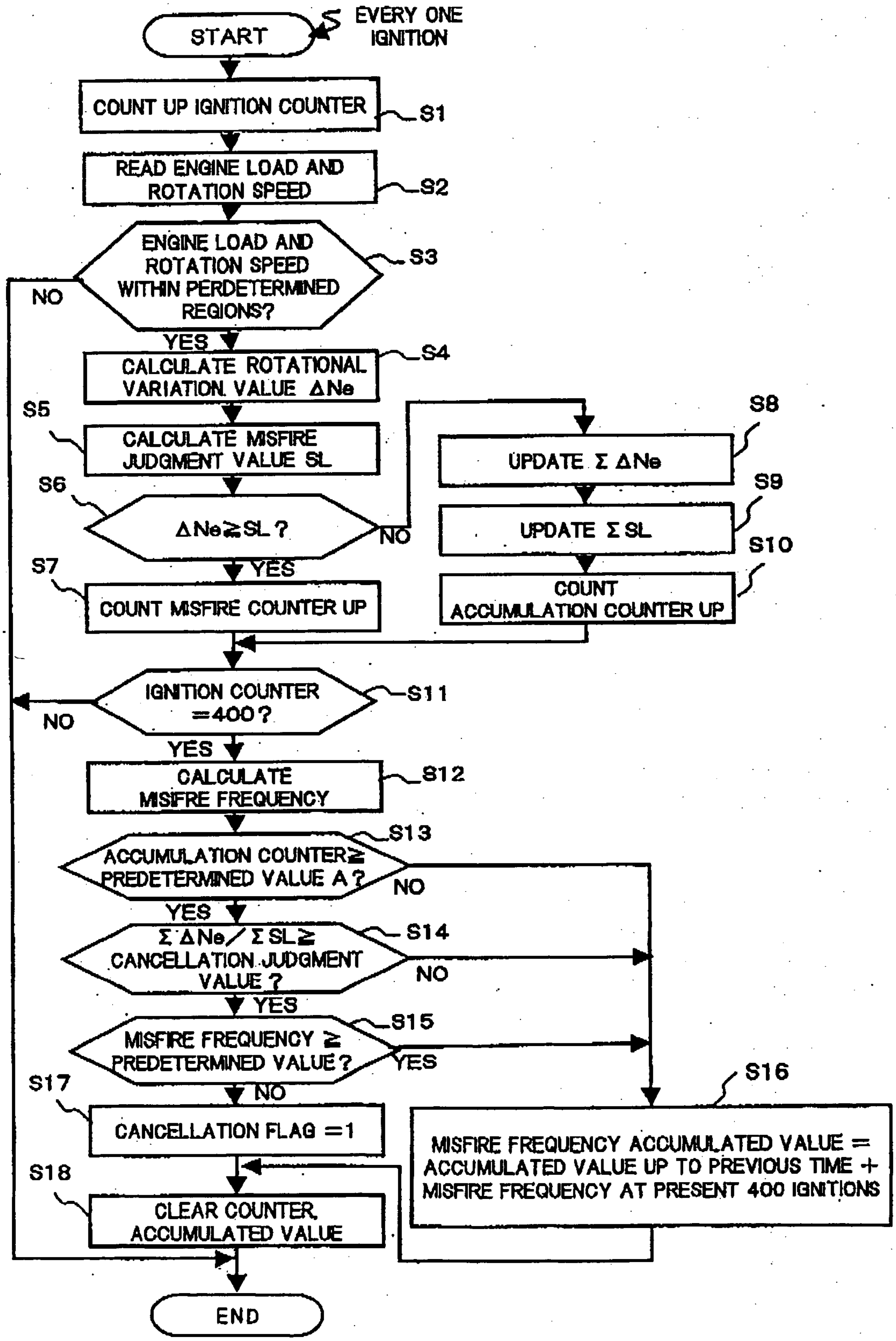

START
EVERY ONE IGNITION
COUNT UP IGNITION COUNTER
S1
READ ENGINE LOAD AND ROTATION SPEED
S2
ENGINE LOAD AND ROTATION SPEED WITHIN PERDETERMINED REGIONS?
S3
NO
YES
CALCULATE ROTATIONAL VARIATION VALUE ΔNe
S4
S5
CALCULATE MISFIRE JUDGMENT VALUE SL
S6
ΔNe≧SL ?
NO
YES
S7
COUNT MISFIRE COUNTER UP
S8
UPDATE Σ ΔNe
S9
UPDATE Σ SL
S10
COUNT ACCUMULATION COUNTER UP
IGNITION COUNTER =400 ?
S11
NO
YES
CALCULATE MISFIRE FREQUENCY
S12
S13
ACCUMULATION COUNTER≧ PREDETERMINED VALUE A ?
NO
YES
Σ ΔNe／Σ SL≧ CANCELLATION JUDGMENT VALUE ?
S14
NO
YES
S15
MISFIRE FREQUENCY ≧ PREDETERMINED VALUE ?
YES
NO
S16
S17
CANCELLATION FLAG =1
MISFIRE FREQUENCY ACCUMULATED VALUE = ACCUMULATED VALUE UP TO PREVIOUS TIME + MISFIRE FREQUENCY AT PRESENT 400 IGNITIONS
S18
CLEAR COUNTER, ACCUMULATED VALUE
END

FIG. 3

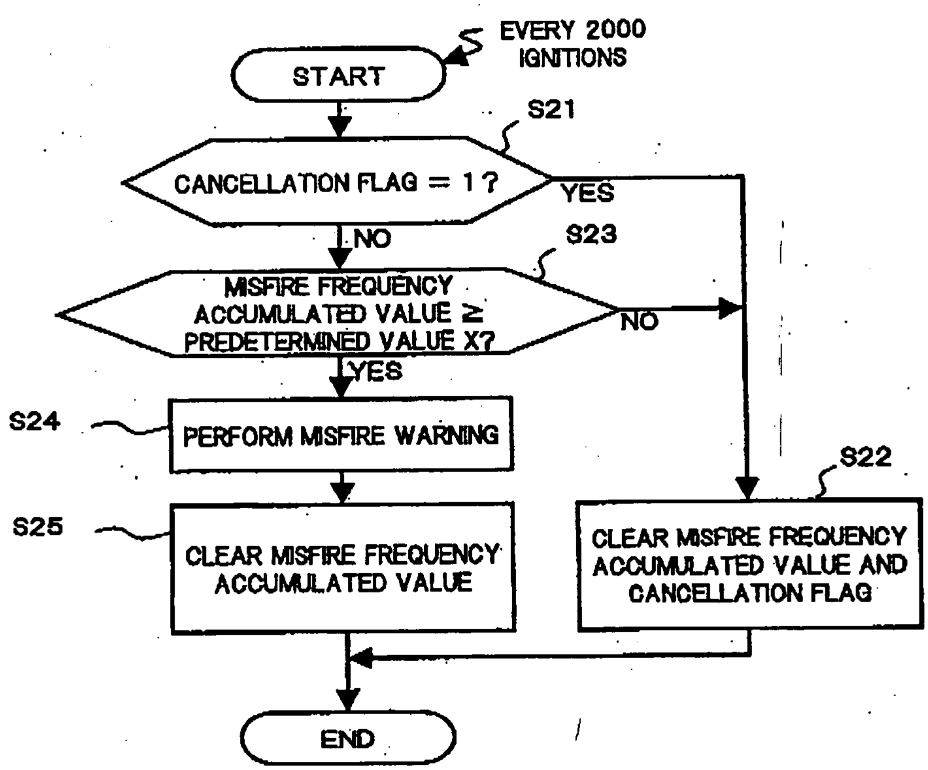

EVERY 2000 IGNITIONS
START
S21
CANCELLATION FLAG = 1 ?
YES
NO
S23
MISFIRE FREQUENCY ACCUMULATED VALUE ≥ PREDETERMINED VALUE X?
NO
YES
S24
PERFORM MISFIRE WARNING
S25
CLEAR MISFIRE FREQUENCY ACCUMULATED VALUE
S22
CLEAR MISFIRE FREQUENCY ACCUMULATED VALUE AND CANCELLATION FLAG
END

FIG.4

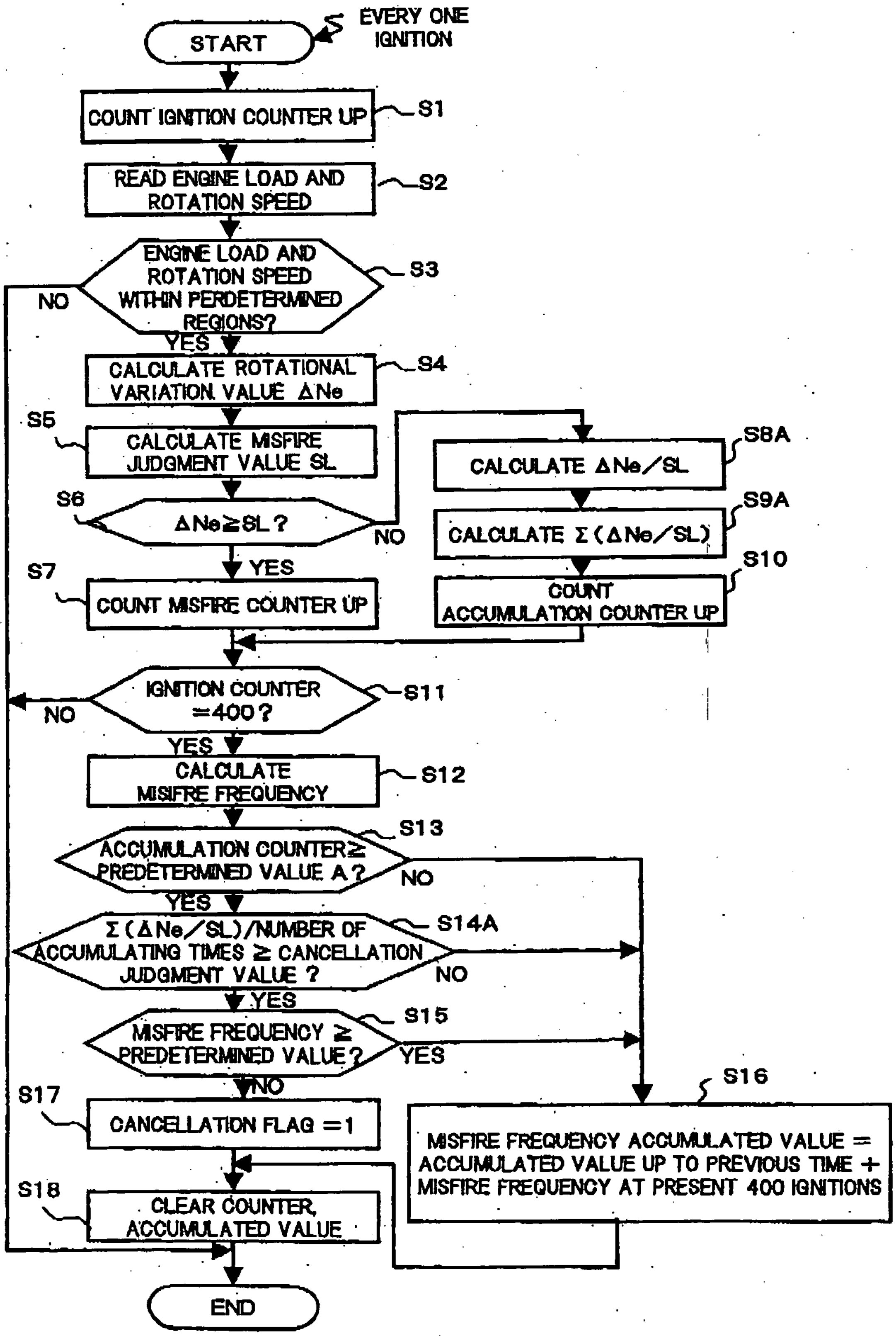
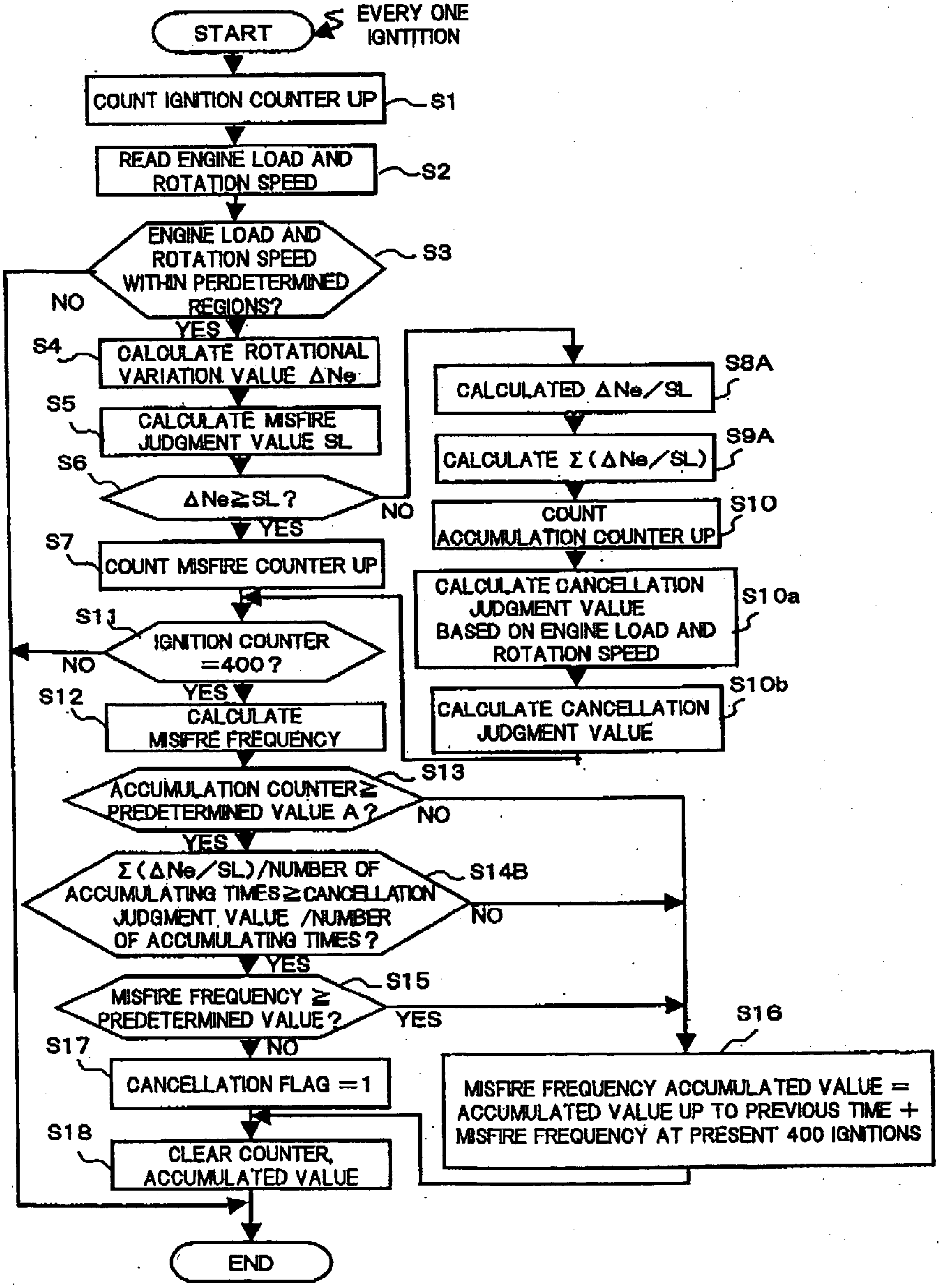

EVERY ONE IGNITION
START
COUNT IGNITION COUNTER UP
S1
READ ENGINE LOAD AND ROTATION SPEED
S2
ENGINE LOAD AND ROTATION SPEED WITHIN PERDETERMINED REGIONS?
S3
NO
YES
CALCULATE ROTATIONAL VARIATION VALUE ΔNe
S4
S5
CALCULATE MISFIRE JUDGMENT VALUE SL
S6
ΔNe≧SL ?
NO
YES
S7
COUNT MISFIRE COUNTER UP
CALCULATE ΔNe/SL
S8A
CALCULATE Σ(ΔNe/SL)
S9A
COUNT ACCUMULATION COUNTER UP
S10
IGNITION COUNTER =400 ?
S11
NO
YES
CALCULATE MISFIRE FREQUENCY
S12
ACCUMULATION COUNTER≧ PREDETERMINED VALUE A ?
S13
NO
YES
Σ(ΔNe/SL)/NUMBER OF ACCUMULATING TIMES ≧ CANCELLATION JUDGMENT VALUE ?
S14A
NO
YES
MISFIRE FREQUENCY ≧ PREDETERMINED VALUE ?
S15
YES
NO
S16
MISFIRE FREQUENCY ACCUMULATED VALUE = ACCUMULATED VALUE UP TO PREVIOUS TIME + MISFIRE FREQUENCY AT PRESENT 400 IGNITIONS
S17
CANCELLATION FLAG =1
S18
CLEAR COUNTER, ACCUMULATED VALUE
END

FIG.5


START
EVERY ONE IGNITION
COUNT IGNITION COUNTER UP
S1
READ ENGINE LOAD AND ROTATION SPEED
S2
ENGINE LOAD AND ROTATION SPEED WITHIN PERDETERMINED REGIONS?
S3
NO
YES
S4
CALCULATE ROTATIONAL VARIATION VALUE ΔNe
S5
CALCULATE MISFIRE JUDGMENT VALUE SL
S6
ΔNe≧SL ?
NO
YES
S7
COUNT MISFIRE COUNTER UP
S8A
CALCULATED ΔNe/SL
S9A
CALCULATE Σ(ΔNe/SL)
S10
COUNT ACCUMULATION COUNTER UP
S10a
CALCULATE CANCELLATION JUDGMENT VALUE BASED ON ENGINE LOAD AND ROTATION SPEED
S10b
CALCULATE CANCELLATION JUDGMENT VALUE
S11
IGNITION COUNTER =400?
NO
YES
S12
CALCULATE MISFIRE FREQUENCY
S13
ACCUMULATION COUNTER≧ PREDETERMINED VALUE A?
NO
YES
S14B
Σ(ΔNe/SL)/NUMBER OF ACCUMULATING TIMES≧CANCELLATION JUDGMENT VALUE /NUMBER OF ACCUMULATING TIMES?
NO
YES
S15
MISFIRE FREQUENCY ≧ PREDETERMINED VALUE?
YES
NO
S16
MISFIRE FREQUENCY ACCUMULATED VALUE = ACCUMULATED VALUE UP TO PREVIOUS TIME + MISFIRE FREQUENCY AT PRESENT 400 IGNITIONS
S17
CANCELLATION FLAG =1
S18
CLEAR COUNTER, ACCUMULATED VALUE
END